

Dynamics of Marine Ecosystems
Recitation 3. Friday, October 14, 2011
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1. Definitions

- a. ITCZ: intertropical convergence zone; region near the equator where winds from the N & S hemispheres meet; on average, is centered slightly N of the equator
- b. Trade winds: Easterlies in the $\sim 0\text{-}30^\circ$ latitude N & S of the equator
- c. Polar easterlies: Easterlies in the $\sim 60\text{-}90^\circ$ N & S of the equator
- d. Hadley cell: region of rising air at the equator & sinking air at $\sim 30^\circ$ N & S of the equator. Process of rising & sinking plus Coriolis creates the Trade winds
- e. North Equatorial Counter Current: eastward flowing water $\sim 10\text{-}20^\circ$ N of the Equator. Go over simple creation of this by the winds
- f. Equatorial Undercurrent: $<5^\circ$ -wide current that flows eastward under the Pacific equator. From $\sim 100\text{m} - 400\text{m}$ depth
- g. Walker circulation: Rising of warm, moist air over the western equatorial Pacific; sinking of cold air over the eastern equatorial Pacific. Helps set up strong Trade winds.
- h. Greenwich & the International Dateline: Greenwich is 0° longitude & the Intl Dateline is 180° longitude. Numbers increase from the UK to the western Pacific, E for lines E of the UK and W for lines W of the UK
- i. ENSO: El Nino Southern Oscillation, 5-ish year cycle in the Pacific; drives global climate cycles. EN warm periods. LN cooler periods.
- j. SOI: differences in surface air pressure between Tahiti & Darwin; EN is a negative SOI.
- k. Anomaly: deviates from standard, normal.
- l. Cd/Ca, Ba/Ca, Mg/Ca, Sr/Ca: Cd for phosphorus, Ba for nutrients, Mg & Sr for temp, but affected by salinity too
- m. Biomarkers: biologically synthesized compounds

- n. Alkenones: highly resistant organic compounds produced by prymnesiophytes (cocco's)
- o. "del" notation:
- p. PDB/SMOW: standards for O & C isotopes. Arbitrarily assigned as 0 per mil
- q. Rayleigh distillation:

See L. Sikes's lecture 10/7/11 page 7, both panels

- r. $\delta^{13}\text{C}$ with depth:

See L. Sikes's lecture 10/7/11 page 8 bottom panel

- s. Linear Tracking Window hypothesis: if the generation time (\sim lifetime) scale = \sim the environmental signal scale, then you can track changes in the org's population in response to the env signal
- t. PDO; + = warmer in NE Pac; - = colder in NE Pac; decadal time scale
- u. PDO + ENSO are additive
- v. NAO: decadal timescale. Sea level pressure diff btwn Reykjavik & Lisbon. + = warmer NE Atl; - = colder NE Atl.

2. Practice Problems

- a. Although ENSO causes and effects are a bit of a chicken and egg game, it is useful to understand the sequence of events one a starting point is chosen. I have chosen average-strength trade winds as the starting point. Draw several diagrams to represent how the N. and S. Equatorial Currents and N. Equatorial Counter Current are set up. Remember to have Coriolis balance geostrophy.

See J. Wilkin's notes from 10/3/11 page 3, bottom panel.

b. Isotopes can be fun, really. Answer the following questions to see just how fun they can be:

i. Water evaporates over a warm part of the ocean. The cloud drifts toward land and then rains out all of its contents that then flow over the surface of the land back to the ocean. When the cloud is still present, but before it rains, how is the $\delta^{18}\text{O}$ different between the ocean and the cloud? After the rain is done, how has the ocean $\delta^{18}\text{O}$ changed?

a. $\delta^{18}\text{O}$ of the cloud is negative (somewhere between -1 and -20 per mil). The ocean will be made slightly positive (or enriched in the heavy isotope) but by such a small bit that we say it hasn't changed; its $\delta^{18}\text{O}$ remains 0 per mil.

b. Because all of the O, regardless of being ^{16}O or ^{18}O , has been returned to the ocean, its $\delta^{18}\text{O}$ hasn't changed as long as all the water from the cloud rains back into the same part of the ocean.

ii. Same scenario as above except only some of the rain leaves the cloud over the land. The rest travels further north and then all snows out as ice over the Arctic. Now how do the $\delta^{18}\text{O}$ pools in the ocean, land, and ice differ?

Traveling north (and therefore colder as long as we're in the northern hemisphere), doesn't change the $\delta^{18}\text{O}$ signature of the cloud. The $\delta^{18}\text{O}$ only changes if some of the

water vapor leaves the cloud as rain or snow BEFORE it all snows out over the Arctic. If rain left the cloud before getting to the Arctic, the ice would be even more depleted than the original cloud.

In this case, the ice stays in the Arctic and the depleted O doesn't return to the ocean. Therefore the ocean becomes slightly enriched. As long as we're just considering one cloud, the isotopic change to the ocean is so small that we say its $\delta^{18}\text{O}$ is still 0 per mil.

- iii. You have two identical coastlines that have inland lakes. Their only difference is that coastline and lake #1 are at 10° N while coastline and lake #2 are at 60° N. If ocean water evaporates at each coastline to form clouds that then rain their entire contents into their respective lakes, how do the $\delta^{18}\text{O}$ of the two lakes differ? Assume that the water stays in the lakes and doesn't flow back into the ocean.

The cloud at the higher latitude would be more negative than the cloud (of the same size) formed at a lower latitude. Their resulting lakes would continue this relationship.

- c. I am a fisherwoman in California who prefers to fish anchovies. How do I fair financially in an ENSO warm event year? How do I fair in a (-) PDO year?

I would do poorly in an ENSO warm event year and would do well in a -PDO year.